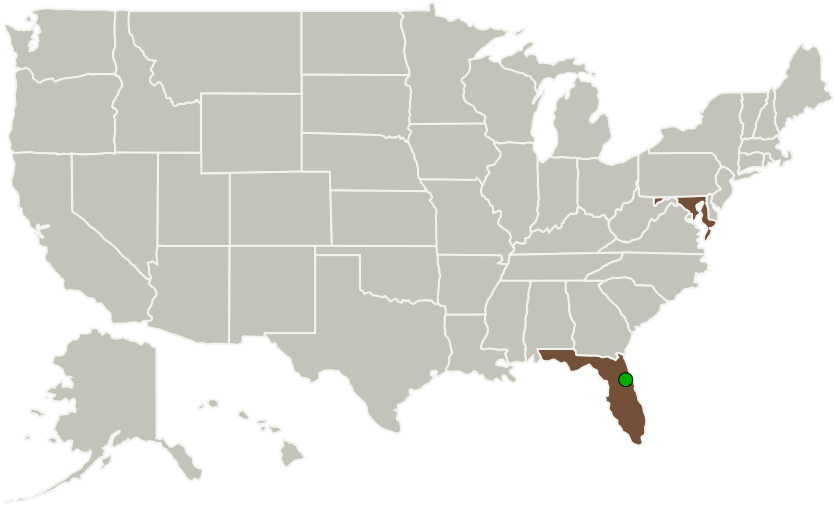
Unpowered Wireless Ultrasound Generation and Sensing for Structural Health Monitoring of Composites, Phase I

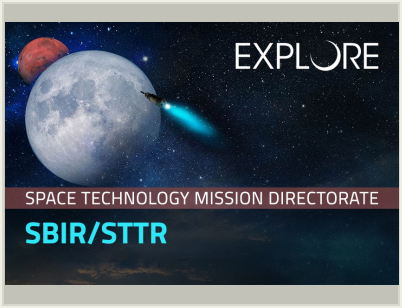
Completed Technology Project (2012 - 2012)

Project Introduction

Damage detection based on ultrasonic waves is one of the most popular inspection schemes employed by many structural health monitoring (SHM) systems. We propose a novel unpowered wireless ultrasound generation and sensing system for SHM. Since ultrasonic signals generally have a frequency of a few tens of kilohertz to a few megahertz, they cannot be easily transmitted using a wireless means because of high sampling and high bandwidth requirements. Our system uses a frequency mixer to up-convert the ultrasonic signal to microwave frequency so that it can be transmitted wirelessly using a small antenna and down-convert the ultrasonic signal back to its original frequency once the wireless signal is received. Because the mixing of the ultrasound and the microwave signal is performed using a passive microwave component, i.e. a frequency mixer, the wireless sensor nodes do not need any local power. For ultrasound generation, an ultrasound-modulated signal is transmitted to a remote ultrasound generator, the generator recovers the ultrasound excitation signal using down conversion and supply it to a piezoelectric actuator. Since the sensing and generating nodes have the same configuration, each node can either act as a generator or a sensor. Sensor array can also be implemented. Compared to SAW sensor, our approach requires smaller antenna and achieves longer distance between interrogation unit and the sensor. Another key difference is that SAW sensor requires special piezoelectric substrate whereas our approach can use any piezoelectric sensor. Finally, the proposed approach is compatible with previous works on ultrasound-based technology. Previously developed knowledge on data processing and feature extraction can be easily adopted.

Primary U.S. Work Locations and Key Partners





Unpowered Wireless Ultrasound Generation and Sensing for Structural Health Monitoring of Composites, Phase I

Table of Contents

Unpowered Wireless Ultrasound Generation and Sensing for Structural Health Monitoring of Composites, Phase I

Completed Technology Project (2012 - 2012)

Organizations Performing Work	Role	Type	Location
Signal Processing, Inc.	Lead Organization	Industry Minority-Owned Business, Small Disadvantaged Business (SDB), Women-Owned Small Business (WOSB)	Rockville, Maryland
Kennedy Space Center(KSC)	Supporting Organization	NASA Center	Kennedy Space Center, Florida

Primary U.S. Work Locations	
Florida	Maryland

Project Transitions

February 2012: Project Start

August 2012: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138558)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Signal Processing, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Chiman Kwan

Co-Investigator:

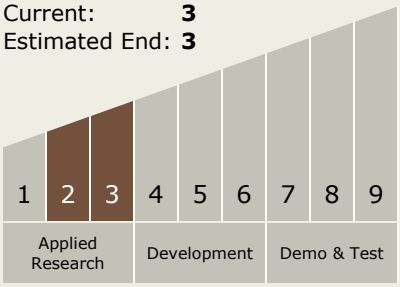
Chiman Kwan

Unpowered Wireless Ultrasound Generation and Sensing for Structural Health Monitoring of Composites, Phase I

Completed Technology Project (2012 - 2012)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.4 Mission Success Technologies
    - TX13.4.5 Operations, Health and Maintenance for Ground and Surface Systems

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System